



Protecting Stored Critical Parts from Corrosion and Heat Damage

Army Corrosion Summit 2010

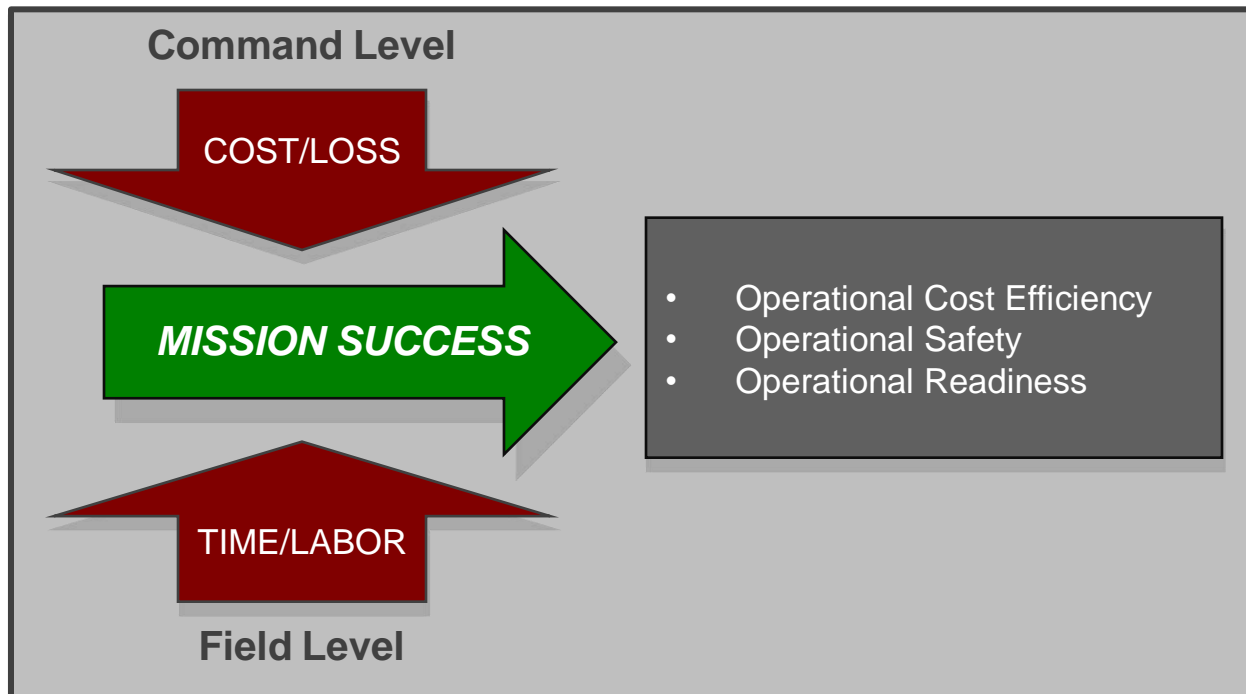
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Parts Loss Situational Analysis

- US Military holds billions in spare parts
- Every year the military loses 10% plus because the parts are hammered by the elements
- Costs = mission, safety, effort and money





GAO has studied this issue to exhaustion!

- The GAO has identified corrosion as the single largest controllable cost in the weapons system lifecycle with more than \$20B spent annually to fight the effects of.
- In 2003, the GAO report on Corrosion in the DoD (GAO-03-753) estimated that the Army's 2,770 helicopters and fixed-wing aircraft require \$4B in corrosion repair annually (this translates to \$1.4MM per aircraft per year in corrosion-related repair costs)
- “Provide shelters and humidity-controlled protection for equipment stored outside. A previous research task showed reduction in corrosion by a factor of 65 from protected storage over uncovered storage.” – *DoD Report to Congress on Long-term Strategy to Reduce Corrosion and the Effects of Corrosion, Table III-2*
- “Storage in controlled temperature/humidity buildings is of course, ideal.” [Department of Defense. “Military Handbook: Electronic Reliability Design Handbook” MIL-HDBK-338B, 1 October 1998, p. 11-61]



We understand the root cause of degradation ...

PROBLEM

CAUSE

CORROSION

The process of degrading or weakening of a metal by something that reacts with the metal, specifically the electrochemical reaction facilitated by the presence of water molecules which cause oxidation (rust) to occur. Exposure to extreme heat, wide temperature cycling, and minerals such as salt, calcium and sulfur may accelerate the process. High humidity levels can also degrade wiring.

PARTICULATE DAMAGE

A wide variety of airborne particulates – dust, sand, and other pollutants – cause damage through both accumulation and the process of abrasion.

CHEMICAL DEGRADATION

Salts (chlorides) and acids (sulfurs) enhance condensation as a result of changes in vapor pressure leading to the amplification of corrosion.

ULTRAVIOLET RADIATION

UV degradation breaks down common rubbers and polymers such as polypropylene and polyethylene and is absorbed by pigments and dyes resulting in fading, cracking, and loss of molecular strength.

TEMPERATURE EXTREMES

High temperature increases the process of oxidation (corrosion) and imposes severe stress on electrical components.

Wide temperature cycling induces stress through expansion and contraction.

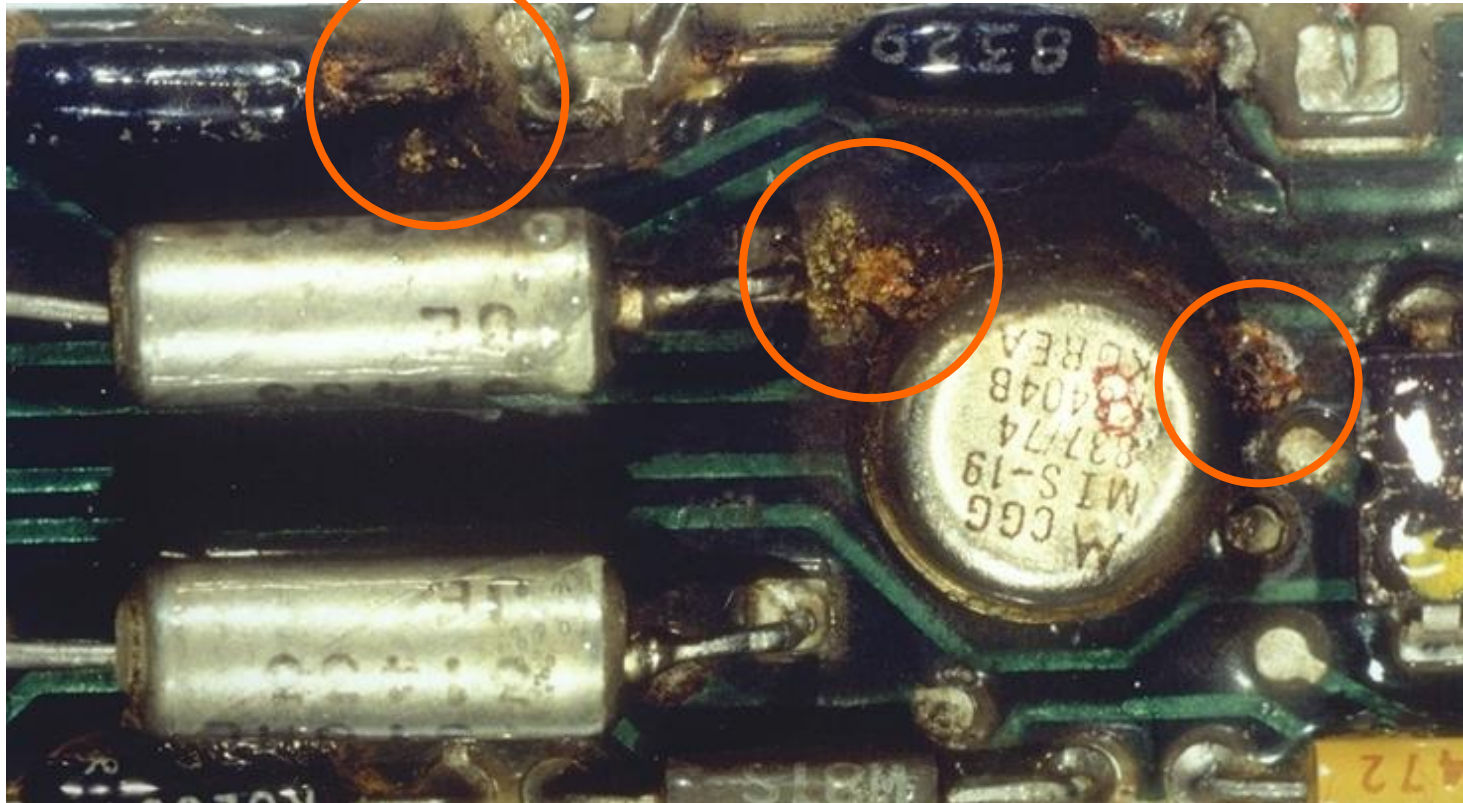
THE GREENHOUSE EFFECT

The corrosive effects of heat, moisture, and other chemical contaminants, are greatly amplified in a trapped/enclosed space.

SPECIAL CONDITIONS

Other detrimental variables such as ice, pollen, mold, or mildew may exist in certain environments.

There is an overwhelming amount of documented corrosion examples and its impact.



A typical scenario ... containerized MRAP field parts valued \$600,000+





Typical ... Chinook Transmission \$100,000+ destroyed





So ... we know the problem, the cause of the problem, and the cost of the problem ... now what?

Success at Sea (the most destructive of environment)

Military Sealift Command Preposition Storage works 100% of the time. Will work on shore!

- MSC Preposition ships carry critical assets for up to five years and those assets need to be in war ready condition when called on.
- Preposition cargo can be weapons, ammunition, field hospitals and medical supplies, rolling stock, aviation parts etc.
- The assets are stored in humidity and often temperature controlled environmentsDryCoolClean!
- Humidity and temperature data is independently and automatically collected and reported back to MSC headquarters to verify specified conditions are being maintained.
- Problems are identified and corrected quickly to deliver 100% success ...which means every munitions, hospital unit, tank, and aircraft part are in war ready condition every single time they are called on ... *can you say that about your critical spare parts?*





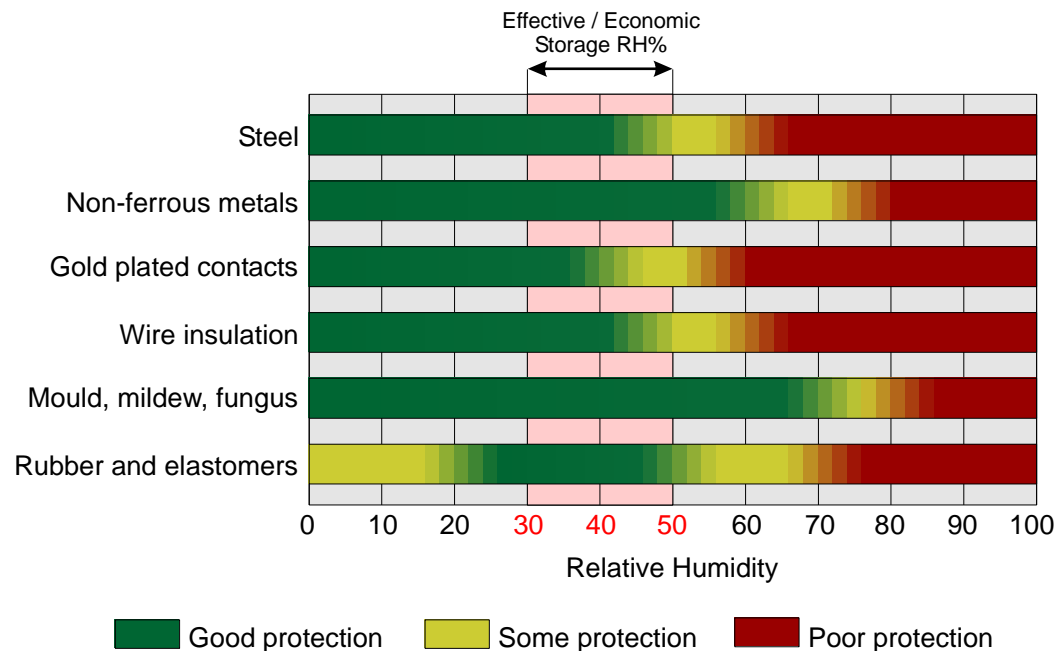
Applied DryCoolClean technology will mitigate corrosion and heat damage!

- Turning your warehouse, storage rooms, parts towers and containers in to DryCoolClean controlled environments is relatively simple and cost effective.
- Correctly designed and installed DryCoolClean systems operates with very little user interface for years and years and years.
- DryCoolClean delivers **HUGE ROI**

Protection from the Elements – DRY Air

Dry Air/Environment:

- By controlling moisture/RH (which results in the process of “electrolysis”), the corrosion of metals is prevented.
- Protects electronics by eliminating contact oxidation and moisture penetration into wire insulation
- Prevents mold, mildew, and fungus from growing
- Corrosion is minimized in environments where RH is maintained at or below an ideal of ~45%





Protection from the Elements – COOL Air

Cool (Temperature-controlled) Air/Environment:

- *High Temperature* causes damage:

“High temperatures impose a severe stress on most electronic items since they can cause not only catastrophic failure (such as melting of solder joints and burnout of solid-state devices), but also slow, progressive deterioration of performance levels due primarily to chemical degradation effects. It is often stated that excessive temperature is the primary cause of poor reliability in electronic equipment.” [Department of Defense. “Military Handbook: Electronic Reliability Design Handbook” MIL-HDBK-338B, 1 October 1998]

- *Temperature Cycling* causes fatigue:

“Temperature cycling can cause fatigue and fracture by inducing stresses on different components as well as inside components. The possibility of damage is dependent upon the magnitude of temperature cycling and length of exposure time. The temperature cycling [i.e. “range”] of 20 degrees Celsius [68 degrees F] is possible in some environments and prolonged exposure can result in component failures.” [Carchia, Michael. “Non-Operating Reliability” Dependable Embedded Systems 18-849b, Spring 1999]

- To ensure ideal conditions for sensitive avionics storage (generally *static* state), maintain within a 50 degree F range, between approximately 55 and 105 degrees F
- To ensure compliance in working environments (shops and other *active* spaces), maintain between 60 and 85 degrees with dehumidification



Protection from the Elements – CLEAN Air

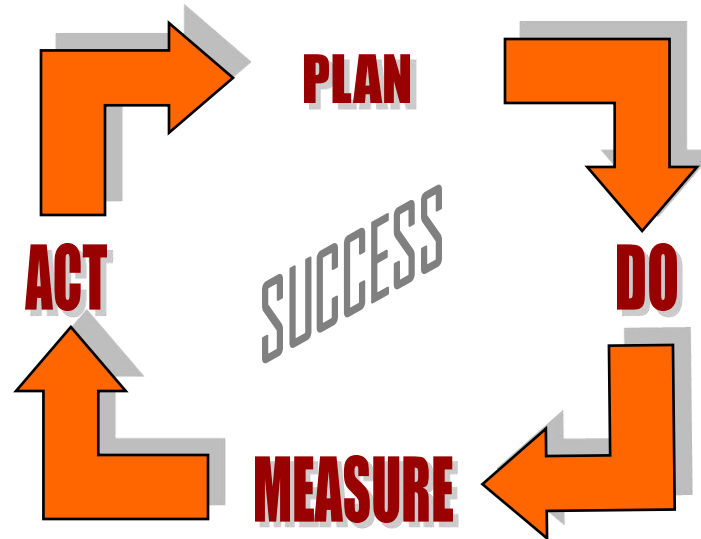
Clean Air/Environment:

- *Salts and sulfurs* (airborne pollutants) enhance process of corrosion and are typically present in all environments; higher salt amounts at sea coast:
 - Salts have a lower vapor pressure than metals, so when the particles land on the metal surface, they attract moisture to the surface at humidity below 100%RH
 - Sulfurs are gaseous pollutants actively present in the atmosphere resulting predominantly from the burning of coal, oil, and gasoline and has been identified as one of the most important air pollutants which contributes to the corrosion of metals
- *Other airborne particles* - sand, dust, etc. - cause additional abrasive damage
- Clean air filter applications need to be sized to local risks

Monitoring and Management needed for Success

- Because corrosion happens site unseen a management/measurement system is needed to insure specified DryCoolClean conditions are being maintained and operational problems are addressed timely for success.

Traditional Management/Measurement System





Success ... The Hunter AAF Parts Warehouse Experience

- AMCOM Corrosion Program Office installed a DryCoolClean system and evaluated parts loss for 12 months
- Average value parts stored in warehouse = \$15-20 million
- Projected annual loss prior to installation = \$2.25-3 million
- Solution = DryCoolClean air (<45%RH, 60-85 degrees F)
- Parts “lost” since installation = \$0
- ROI = >1000% (or 100% within 5 weeks)
- Additional positive impact on readiness, reduced labor hours, and safety

Hunter Army Air Field Critical Aviation Parts Protection
Mid Term Report

July 2, 2009

SUBJECT: Evaluation of Critical Aviation Asset Protection Success at Hunter Army Air Field

1. The purpose of this memorandum is to recognize the initial findings from evaluation of a Critical Component Preservation System that was designed, developed and installed at Hunter Army Air Field, Hunter, Alabama in the summer 2008 for 3rd Bn, 160th SOAR.
2. Cocoon, Inc. of North Hampton, New Hampshire working under the Army Aviation and Missile Command Corrosion Program office design and develop an effective solution to the unit's critical asset protection needs based on their unique expertise in the field of corrosion control and asset protection.
3. Building #7909 serves as a storage warehouse for mission-critical aircraft components (specifically for MH47 and MH60 helicopters) and other parts inventory that are vital to 160th SOAR mission readiness. On average, an estimated \$15-20 million in spare aircraft parts are actively stored.
4. The typical loss of parts to corrosion had been conservatively projected to be \$2.25 - \$3.00 million annually, or 15% of the standard inventory prior to installation of the new protection system. Parts losses had a negative impact on safety and readiness.
5. In order to eliminate the environmental conditions that allow the process of corrosion to occur, a solution was designed to deliver and maintain a controlled environment with clean, dry, cool air. This includes maintaining a rate of less than 45% relative humidity to prevent oxidation from occurring, and temperature control to prevent electronic failures and 30 degree temperature range (60-90 deg F). The system also focused on employing the most energy-efficient process available, substantially reducing operating costs and energy consumption.
6. Other LEED credit-worthy and environmentally-friendly benefits include: providing additional outdoor air ventilation, reducing ozone depletion, the recycling of waste heat and reclaiming of water condensation.
7. Since installation of the DH/AC system, no newly-stored parts have been “lost” or written-off due to corrosion, thus ensuring both mission readiness and safety, significantly reducing the cost of parts replacement and eliminating the labor hours associated with reconditioning maintenance. Projected annual cost saving of more than \$2 million annually. Projecting positive impact to safety and readiness.
8. Findings to-date indicates that return-on-investment was achieved within a very impressive 4-5 weeks with an ROI in excess of 1,000%.
9. The POC for this initiative: Mr. Mark Mills, Hunter AAF DPW Project Manager (912) 315-2351; Mr. Steven F. Carr, AMCOM Corrosion Program Manager: (256) 876-7472.

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C O N C L U S I O N ...

Its time to implement the proven DryCoolClean technology for parts storage to save the government millions of dollars, improve readiness and increase safety.